Wind Farm Technology: Is it the Answer?

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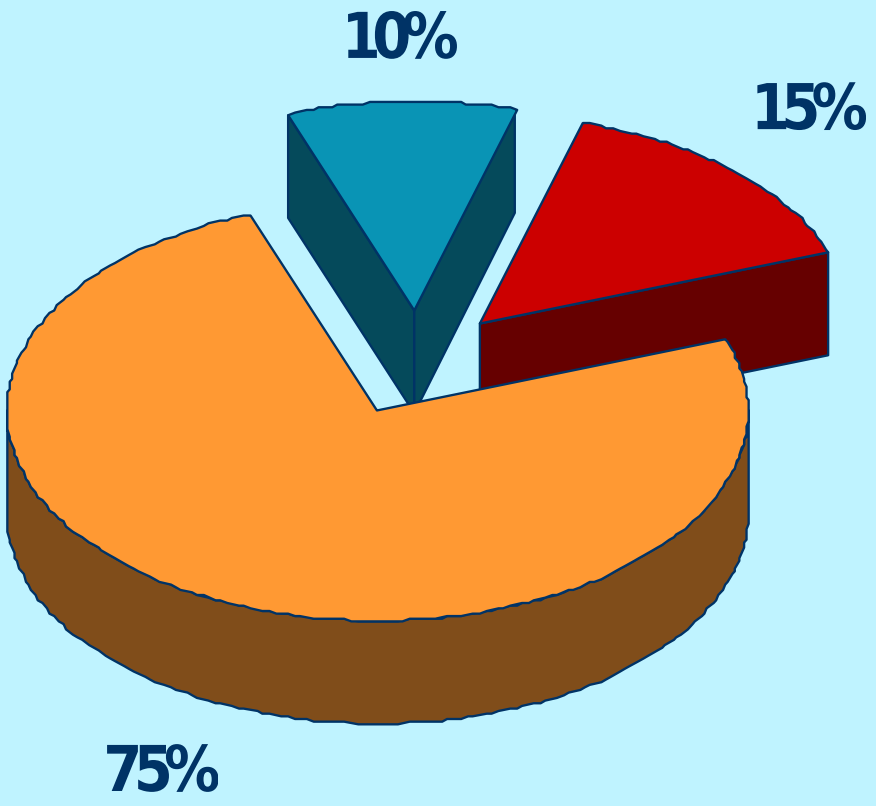
Wind Industry Overview

- Global wind power capacity grew from 7,600 MW in 1997 to 31,000 MW in 2002
- Targeted wind electric capacity of 100 GW in the U.S. by 2020
- Current wind energy generating cost is at 3-5 cents per kWh

Worldwide Wind Energy Generation



World Wind Leaders:

1. Germany
2. Spain
3. U.S.
4. Denmark
5. India

Why Wind Power?

- Federal mandates
- Energy security
- Environmental benefits
- Good wind resources
- Cost competitive
- DoD opportunities

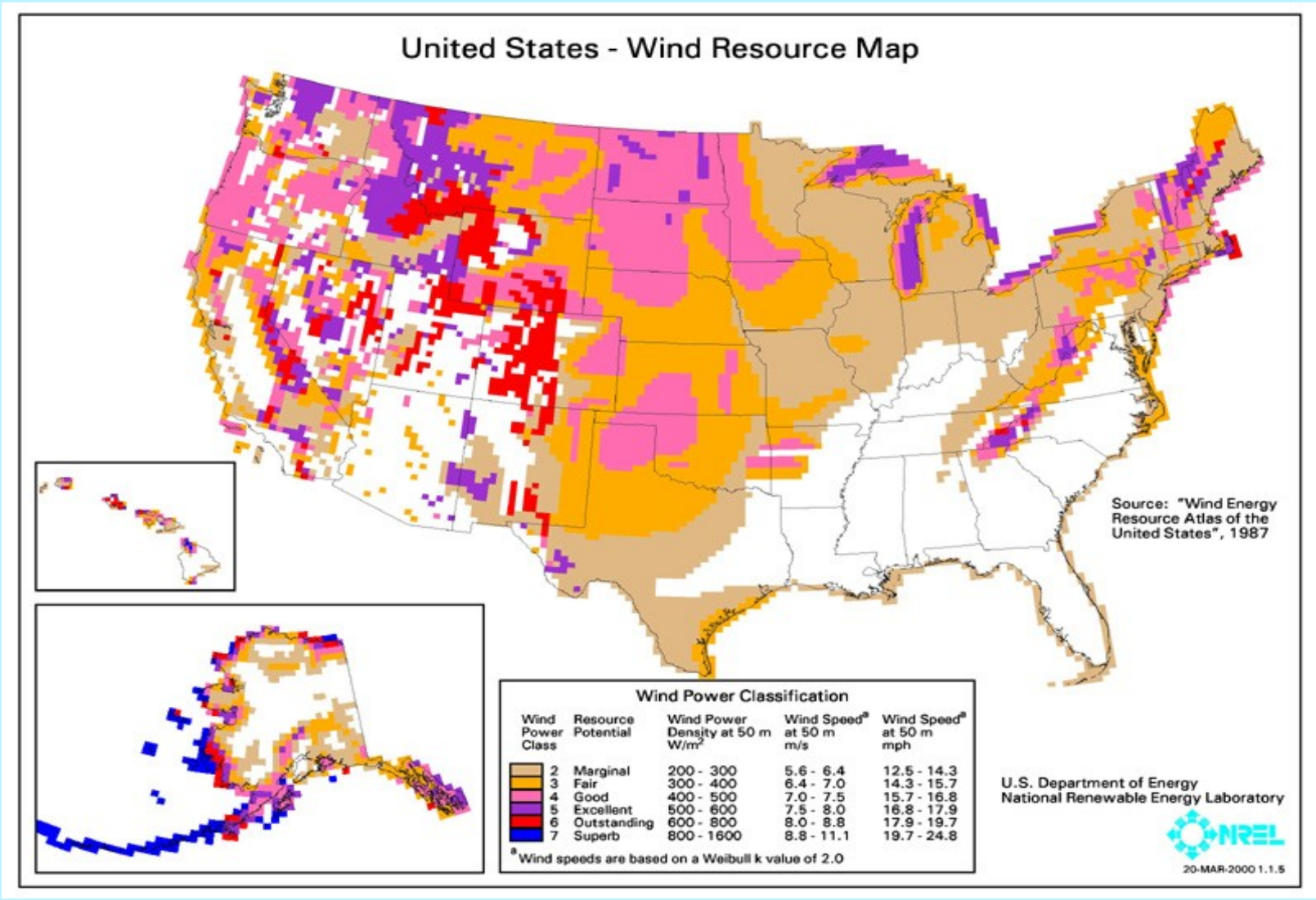
Federal Mandates and Initiatives

- **E.O. 13123** mandates a 35% cut in energy usage by 2010 and a 30% reduction in greenhouse gas emissions between 1990 and 2010.
- **E.O. 12902** mandates that Federal agencies implement renewable energy programs where practical.
- **Renewable energy assessment** – a road map for DoD to develop renewable energy resources “on or near” military bases in the U.S.

DoD Wind Energy Assessment

- Lead by Air Force for DoD.
- Approximately 20 sites have been selected for detailed wind data collection.
- Assessment due to Congress in Summer 2004.

U.S. Wind Resources


United States - Wind Resource Map
Source: "Wind Energy Resource Atlas of the United States", 1987
Wind Power Classification
Wind Power Class
Resource Potential
Wind Power Density at 50 m W/m²
Wind Speed[a] at 50 m m/s
Wind Speed[a] at 50 m mph
2 Marginal 200 - 300 5.6 - 6.4 12.5 - 14.3
3 Fair 300 - 400 6.4 - 7.0 14.3 - 15.7
4 Good 400 - 500 7.0 - 7.5 15.7 - 16.8
5 Excellent 500 - 600 7.5 - 8.0 16.8 - 17.9
6 Outstanding 600 - 800 8.0 - 8.8 17.9 - 19.7
7 Superb 800 - 1600 8.8 - 11.1 19.7 - 24.8
[a] Wind speeds are based on a Weibull k value of 2.0
U.S. Department of Energy
National Renewable Energy Laboratory
NREL
20-MAR-2000 1.1.5

Top 17 States with High Wind Energy Potential

1	North Dakota	11	Colorado
2	Texas	12	New Mexico
3	Kansas	13	Idaho
4	South Dakota	14	Michigan
5	Montana	15	New York
6	Nebraska	16	Illinois
7	Wyoming	17	California
8	Oklahoma		
9	Minnesota		
10	Iowa		

Driving Costs Down Further

- Advancement in turbine technology
- Increasing demand for advanced wind systems

DoD Opportunities for Wind Power

- Emerging security requirements
- Isolated locations
- Emission reduction goals
- Diversify fuel portfolio
- Reduce fuel price volatility risk
- Save money

Criteria for Developing Wind Energy

- Sites with good wind resources
- Facilities with high cost of electricity
- Diesel oil and fuels are currently being transported to the site for power generation
- Current power generation systems result in non-compliance with environmental regulations

Applications

- Communication equipment
- Navigation aids
- Special military operation requirements
- Pumping and irrigation systems
- Desalination and water treatment systems

Environmental Benefits

- Reduction in air emissions
- Reduction in fuel consumption for power generation
- Renewable and clean energy source

Environmental Concerns

- Visual/aesthetic impact
- Bird and avian mortality
- Recreational activity impacts
- Archaeological site impacts
- Noise pollution
- Potential effects on seabeds (offshore wind farms)
- Navigation and oil spill risk
- Marine mammal activity

San Clemente Island, CA

- Navy Auxiliary Landing Field
- U.S. Navy Island 52 miles off San Diego

San Clemente Island, CA

- Total generating capacity of 675-kW (three 225 kW NEG Micron turbines)
- Provides 17% of the island's electricity demand
- Annual energy saving of $112,000
- Electricity generating cost of 3-4 cents/kWh
- Reduction in diesel fuel usage of over 140,000 Gal
- Reduction in green house gas emissions:
  - Over 3 million lbs of CO2
  - Over 18,000 lbs of CO
  - Over 85,000 lbs of Nox
  - Over 5,600 lbs of SO2
  - Over 6,000 lbs of PM10

Ascension Island

- U.S. Air Force installation on British Island
- Located 500 miles south of the Equator in the middle of the Atlantic Ocean

Ascension Island

- Four 225-kW wind generators
- Electrical generation at a reduce output (0-40 kW)
- Displacing 287,000 Gal of diesel fuel
- Annual saving of $350,000
- Reduction in air emissions:
  - 2.8 million lbs of CO2
  - 98,000 lbs of NOx

Summary

Wind energy presents a cost saving option when the price of fuel currently used is high and the wind resource is good. The remote location on many DoD facilities validates the use of renewable energy in reducing the cost of fuel transportation. The benefits of environmental protection and long-term price stability will increase the utilization of wind farms by DoD.

Wind farms will definitely be part of the future DoD energy solution.